

of N. 50° E. The next arch northward, consisting principally of gneiss, has a diameter varying from twenty-five to thirty miles; its axis runs for some distance along the central ridge of the Grampians. The granite of Cruachan and Ben Muich Dhui interfere with the regularity of the foliation of this district, and the lines are thrown to the north by the granite of Aberdeenshire: the line which bounds this arch on the north crosses the Spey near Laggan, and runs N. 40° E. through Corbine into the Monagh Leagh mountains. To the north of that line, the foliation of the gneiss forms an arch only ten miles wide, bounded on the north by a vertical plane running N. 35° E. which crosses Coryaraick. This plane forms the southern boundary of an arch, varying from fifteen to twenty-five miles wide, entirely of gneiss, bounded on the north by a band of vertical foliation which runs about N. 30° E. from Glen Finnan through the middle of Rosshire and across Ben Nevis. To the north-west of this band there is half an arch in the foliation, varying from twenty to thirty miles wide, which ends abruptly at a line to be drawn from Loch Eribol and Loch Maree, on the west of which the gneiss is unconformable to that hitherto described, but agrees with that of the Island of the Lewis, forming a series of arches which run about N.W.

From the want of parallelism in the lines of foliation of the Highlands, they would all nearly converge between Lough Foyle and Lough Swilly among the mica schists of the North of Ireland.

The most rugged and elevated hills are usually on or near the lines of vertical foliation; the axes of the arches are generally found in high land, and the principal valleys occur between the central axes of the arches and their vertical boundaries. Thus the main physical features of the Highlands are connected with the foliation of the gneiss and schists; but the granites and porphyries which have broken through those rocks, and disturbed the regularity of the foliation, have also greatly modified the surface of the country.

The contortions of gneiss and schists being unaccompanied by fracture, must, the author considers, have been produced when the matter of those rocks was semi-fluid: in this state the mineral ingredients appear to have separated and re-arranged themselves in layers according to their affinities, while the whole was subjected to pressure acting along certain axes of elevation, which raised those layers into arches.

---

February 26, 1852.

COLONEL SABINE, Treasurer and V.P., in the Chair.

The following paper was read:—

“On the Motions of the Iris.” By B. E. Brodhurst, Esq., M.R.C.S. Communicated by Thomas Bell, Esq., Sec. R.S. Received November 20, 1851.

The observations made in this paper are distributed under three

heads. First, the author examines the iris in conjunction with the organic system of nerves. Secondly, he exposes the relation of the several nerves of the orbit in reference to the iris. And, thirdly, by tracing the membrane through the lower orders of animals, he shows the influence of the ophthalmic ganglion upon the iris, and the necessity of its presence for the accomplishment of the motions of the membrane, *i. e.* contraction and dilatation of the pupil.

It is shown that the pupil is most contracted during healthy sleep, and especially during that of childhood; that in death it assumes a median state, neither contracted nor dilated; and that, when disease is present, the pupil is always dilated, and dilated in accordance with the effect produced upon the trisplanchnic system of nerves. Also, it is stated that the pupil is dilated, when through disease the action of the voluntary muscles is abnormally increased, but that it is contracted when the functions of nutrition are well and actively performed; and that, with concussion and compression of the brain, the pupil is usually dilated when the power of the voluntary muscles yet remains; that it is fixed and immoveable when total insensibility exists; contracted when pressure or counter pressure is made upon the corpora quadrigemina of the opposite side, and dilated when the injury is more general, but less severe.

The author refers the first class of motions, or the *primary* motions of the iris, directly to the sympathetic system of nerves; whilst the *direct* movements, or those produced by the sensation of light, are effected through the cerebral nervous arc, as shown by Flourens, Marshall Hall, and others: and he thinks that contraction of the pupil, when a near object is presented to the eye, may be explained by the greater stimulus thus afforded to the retina and the sensorium; for he finds that when a near object is presented to the eye with a faint light, but a more distant one with a strong light, the pupil is most contracted for the more distant object. That the influence of the retina and the cerebral nervous arc is secondary in producing the motion of the iris, and that this membrane is not a mere diaphragm for the admission or exclusion of light, but that it yields to mental impressions, as well as to those which operate on the vegetative system of nerves, in preference to the effect upon the retina, is shown by the result which is produced upon the iris by any sudden passion in causing dilatation of the pupil, notwithstanding that a strong light be at the same time thrown upon the retina. Hippus, and the motions of the iris which are observed, especially in amaurotic children, are alluded to as motions independent of the light, and consequently, of the retina and sensorium.

The author then proceeds to state the effect of irritation and division of the several nerves of the orbit. He finds, that, on irritating the third nerve within the cranial cavity, slight contraction of the pupil ensues, to be followed by dilatation. On dividing the third nerve, the pupil becomes dilated beyond its median extent.

Irritation of the optic nerve within the cranium produces contraction of the pupil. Section of the same nerve gives rise to an insensible retina and a dilated pupil.

Irritation of the fifth nerve excites slight motion in the iris. Division of the fifth produces temporary contraction of the pupil. In the space of half an hour this effect will have ceased, and the pupil will have resumed its former diameter.

If a slight galvanic current be passed along the sympathetic, contraction of the pupil will be produced; but let the sympathetic be divided, at the superior cervical ganglion for instance, and instantly the pupil shall forcibly contract, and again widely dilate.

If a weak galvanic current be used, and the poles brought into contact with the sclerotica at its junction with the cornea, contraction of the pupil to two-thirds of its actual diameter takes place, and this effect continues so long as the current continues to be formed; but on breaking connection, the pupil immediately resumes its former diameter. So soon as life is extinct, galvanism ceases to affect the iris, whether applied to the membrane itself, through the external coats, or though the poles be in contact with the retina; but if applied to the sympathetic, movement may be excited in the iris.

The optic nerve being divided, the pupil is dilated: irritation of the third nerve then produces merely a slight and momentary effect upon the iris; but if the sympathetic be divided, the pupil will contract violently, and again dilate beyond its previous state of dilatation.

The sympathetic being divided, irritation of the cranial nerves does not affect the iris; but though the cerebrum and corpora quadrigemina be removed, division of the sympathetic will still excite the iris to motion. And, consequently, the author infers that the basic or primary motion of the iris is derived from the *vis motoria* of the excito-motor ganglionic system: he shows also, that where the ophthalmic ganglion is wanting, as in fishes and reptiles, the iris is motionless. Allusion is, lastly, made to some medicinal agents, to show their influence upon the nervous centres, and their consequent effect upon the iris: they are classed as follows:—

- I. True depressors and pupil dilators.
- II. True excitants and pupil dilators.
- III. Stimulants which become depressors, which dilate the pupil.
- IV. Excitors of voluntary nerves and pupil dilators.
- V. Sedatives which terminate as depressors, which first contract and then dilate the pupil.
- VI. Excitants which become sedatives, which first dilate and then contract the pupil.

And from what has gone before, it is concluded, that contraction of the pupil is the active state of the iris, and that dilatation is its enervated condition; that a healthy retina and cerebral nervous arc are necessary to the motions of the iris, and the ophthalmic ganglion to motion; and that the primary motion of the iris is due to organic nervous influence, but its forced or animal motion to the reflected stimulus of light upon the retina.